ESA 142-3_Wausau Papers_Rhinelander, WI
Steam ESA – Public Report - Final

Company	Wausau Papers	**ESA Dates**	July 28th to 30th
Plant	Rhinelander	**ESA Type**	Steam
Product	Paper products	**ESA Specialist**	Tom Tucker, P.E.

Table 1*

ENERGY SAVINGS OPPORTUNITY SUMMARY INFORMATION					
Identified Opportunity	**Savings/yr**				
	$	**kWh**	**MMBtu**	**Fuel Type**	**N,M,L**
1. Use Alternate Fuel – Convert Coal Boilers to Burn Wood (biomass)	$1.5-million	0	72,240 (based on expected efficiency gain only)	Coal	M
2. Boiler Efficiency Improvement – Consider Oxygen Trim Controls	$80,800	0	16,395	Coal	M
3. Improve Boiler Efficiency – Operate One Stoker Boiler Instead of Two	$32,320	0	6,558	Coal	N/M
4. Reduce Steam Demand - Reduce DA Steam Vent Rate	$48,000	(-151,200)	5,880	Coal	N
5. Reduce Steam Demand – Perform a Steam Trap Survey and Repair/Replace Defective Traps	$25,000	(-50,400)	3,360	Natural Gas	N
6. Improve Steam and Condensate Distribution System Insulation	$6,450	(-16,800)	840	Natural Gas	N

*The estimates in **Table 1** list the projects separately and there is no allowance for the coincidence of projects.

Table 2

IDENTIFIED PLANT BEST PRACTICES	
Condensate recovery	Based on reported condensate return rates condensate recovery is good.
Boiler Heat Recovery	The boilers include heat recovery to increase boiler efficiency.

Brief Narrative Summary Report for the Energy Savings Assessment:

Introduction:

On behalf of the Department of Energy, Tom Tucker of Kinergetics LLC conducted a steam system ESA at Wausau Papers Rhinelander, Wisconsin facility from July 28th to July 30th, 2008. The ESA and training activities were provided through the United States Department of Energy-Save Energy Now initiative, which was begun to help the largest natural gas users in the United States identify ways to reduce energy use.

The estimated annual energy cost savings for the projects evaluated is provided in **Table 1** above. Utilities for the facility are as follows:

The facility has the flexibility to burn cyclone boiler coal, stoker coal or natural gas to generate steam. The cyclone boiler is used as a base load boiler.

Steam System
Steam is generated with a cyclone boiler as the base boiler, stoker coal boilers and a gas boiler. Gas is used when the cost for coal is too high. Because stoker coal is more expensive than cyclone boiler coal, the stoker boilers were treated as the "impact" boilers, meaning that if any steam reductions are made, the stoker boiler steam output will be reduced.

Boiler steam pressure is reduced through both power and mechanical drive turbines and pressure reducing stations. The following summarizes 2007 steam data.

- Average efficiency: ~70% based on mill 2007 data
- Average steam rate for modeling includes package boiler contribution: 68.8-kpph (54.4-kpph on stoker alone)
- Stoker & package steam estimated at ~28% (23% Current)of the 2007 average
- Blowdown rate: ~2.5%
- The stoker feedwater pump steam estimated at ~6-kpph on average (30% isentropic efficiency). While it is generally difficult to justify replacement of backpressure turbine drives with electric where good use is made of backpressure steam, there may be an opportunity if elimination of the steam load helps move toward, single stoker boiler operation.

Objective of ESA:
Efforts were made to introduce the steam tools to Wausau Paper staff and to identify project opportunities related to steam cost reduction. Some discussions also addressed environmental permitting requirements as related to steam system modification. Kinergetics is providing a preliminary inquiry into options as a courtesy to the mill.

Focus of Assessment:
SSAT was applied to model cost reduction opportunities related to the use of bio-fuels as opposed to coal fuel, improving boiler efficiency and raising energy awareness as it pertains to reducing steam demand spikes due to paper mill operation.

Approach for ESA:
The ESA started with an introduction to the different steam tools. The Steam System Scoping Tool (SSST) is a spreadsheet tool designed to gage how effectively the steam system is managed. SSST was completed during the assessment, with the facility scoring 70.3-percent. Scores above 75-percent are considered good and scores below 55-percent can indicate significant opportunity for improvement.

General Observations of Potential Opportunities:
Below are brief descriptions of each opportunity evaluated. Each opportunity has been rated based on the following definitions:

1. Near term opportunities: Include actions that could be taken as improvements in operating practices, maintenance of equipment or relatively low cost actions or equipment purchases.
2. Medium term opportunities: Require purchase of additional equipment and/or changes in the system such as addition of recuperative air pre-heaters and use of energy to substitute current practices of steam use etc. It would be necessary to carryout further engineering and return on investment analysis.
3. Long term opportunities: Require testing of new technology and confirmation of performance of these technologies under the plant operating conditions with economic justification to meet the corporate investment criteria.

1. Convert Coal Fired Stoker Boiler to Biomass Operation (medium term)

The stoker boilers may be candidates for conversion to wood (biomass) operation. Based on combustion efficiency testing, it is feasible that with a properly engineered retrofit that includes economizers and over-fire air and a suitable grate, that the boiler efficiency could be improved from its existing efficiency to as much as 76-percent.

Cost savings estimates are based on use of the wood fuel to displace stoker fuel and are based on different wood prices based on what they are presently and what they could rise to over time. Cost savings are summarized as follows:

- ~$5.0-million with wood at $40/ton   Biomass unavailable at this price
- ~$3.4-million with wood at $60/ton   Low end pricing of biomass
- ~$1,5-million with wood at $75/ton   Probable pricing delivered.

These cost savings are based on the 2007 average steam rate for stoker and package boiler steam because if the gas boiler were off, the stoker would have to make up the difference. The average steam rate was estimated at approximately

68,800-pph. While the current price for wood fuel in north-middle area of the state is $24 per ton, a price of $60 per ton is assumed as a low end estimate. Site investigation for adequate supply of 10% dried wood chips, was quoted at $75/ton. As a result, the annual cost savings is estimated at $1.5-million, with natural gas pricing at an average of $7.30 dekatherm.

Notes:

1. Initial discussion with those familiar with the applicable environmental rules indicates a conversion of coal boiler to use bio-mass would be favorably received. Given the cost savings potential and that there is a reasonable chance environmental rules will work in favor of this project, it is recommended for further consideration.
2. The energy savings in Table 1 (MMBtu) is based only on the efficiency gain from 70-percent to 76-percent expected with the conversion from coal to a properly design biomass system.

<u>2. Improve Boiler Efficiency – Consider Oxygen Trim Control (medium term)</u>

Oxygen trim control is an automatic means to control boiler efficiency and is controlled by continuous monitoring of the oxygen concentration in the boiler exhaust. Feedback is then provided to a computer that adjusts the combustion air-to-fuel ratio with servo drives and/or a variable frequency drive. This technology is most suited to boilers that experience a wide variation of load.

Combustion testing revealed that the exhaust oxygen is approximately 14-percent, and discussions with personnel indicate that this is likely a good average. Further, discussions indicated that a 3-percent to 4-percent reduction in exhaust oxygen is possible with better controls, which equates to about a 3-percent boiler efficiency gain based on eastern coal. However, to be conservative, a 2.5-percent gain is assumed possible on average.

Analysis indicates that the estimated annual cost savings is approximately $80,800. The plant had already considered this as an opportunity and obtained a quote for $150,000 to complete the necessary work. This opportunity appears to be worthwhile and is recommended for further consideration.

<u>3. Boiler Efficiency Improvement – Operate with One stoker Instead of Two (near/medium term)</u>

Based on discussions, it appears that one of the major reasons that two stoker boilers are operated is lack of energy information presented at the end users in other areas of the mill. Personnel in these areas are unaware of how their decisions influence steam demand requirements. To ensure steam requirements can always be met, two boilers are always on even if one is sufficient to meet steam demand. This causes poor boiler loading and a reduction in boiler efficiency. This is likely one reason the exhaust oxygen is high as discussed in Opportunity 2 above.

Assuming that a gain of 1-percent is obtained by moving to single boiler operation (keep the second one hot, if necessary), the annual cost savings is estimated at $116,000. While some education and training will be necessary, there will likely be minimal implementation cost, beyond the already approved project providing real time energy consumption at the end use consumer.

<u>4. Reduce Steam Demand - Reduce DA Steam Vent Rate (near term)</u>

DA tanks are used for removal of dissolved gases, particularly oxygen. The design guideline vent rate is approximately 1/10 of one percent of the design boiler feedwater flow, which is about 255,000-pph for all boilers. Using the estimated feedwater flow as a guide, the vent rate should be approximately 300-pph, allowing for some additional venting as a safety margin.

While measurement was not possible, the vent rate was estimated to be approximately 700-pph based on visual observation and experience. To be conservative, it is assumed that the vent rate can be reduced by 400-pph, saving an estimated $27,800 per year in boiler fuel cost related to low pressure steam. Generally, valve adjustment is sufficient to reduce venting, but valve replacement may be necessary depending on its condition and whether or not the orifice diameter in the valve gate (if there is one) has been increased through use. This opportunity is recommended for further consideration and implementation as appropriate.

Notes:

1. While visual observation of vent rates can be used as a guide to DA tank performance, changes in the amount of chemical oxygen scavengers should be monitored for indication that the DA tank is still performing as expected. Increase in use of chemical scavengers indicate diminished performance, and the vent rate should be increased

somewhat until the balance is found. This will help minimize the chance for poor oxygen removal and potential boiler damage. Seek assistance from the facility water chemistry service provider.

2. As a general guide, a gap between the DA vent and plume should be approximately 2-inches with the plume 2 to 3-feet in height.

5. Reduce Steam Demand – Perform a Steam Trap/Leak Survey and Take Corrective Actions (near term)

Steam trap problems are evident from steam venting from drains in the paper mill, with one example by PM#8. Water hammer was also noted and is often evidence of failed traps. Based on modeling under the assumption that ten traps have failed on the medium and low pressure systems and that five on each system are repaired (no high pressure failures), the estimated annual cost savings for steam trap repair is $21,000, although the actual savings could be greater. The cost to perform the survey and repair/replace the defective traps is estimated at $20,000 to $40,000.

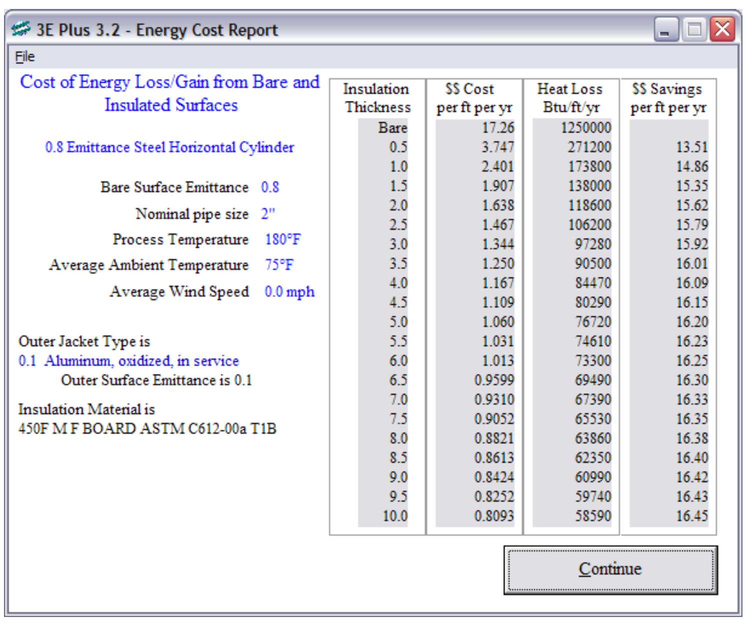
This opportunity is recommended for further consideration.

Notes:

1. Conditioned Water Storage tank by PM#9. Either excess steam is venting to this tank, or the condensate make up is very hot. Excess condensate is overflowing to the drain and steam continually vents from the top. The tank walls are *very* hot. The tank has been since equipped with an excess water recovery system to eliminate the overflow.
2. Aside from steam traps, a number of steam leaks were also identified. Given that repair of steam leaks often has a return less than one year, any leaks should be repaired as soon as is feasible. A leak survey is an effective means to determine the size of the opportunity.

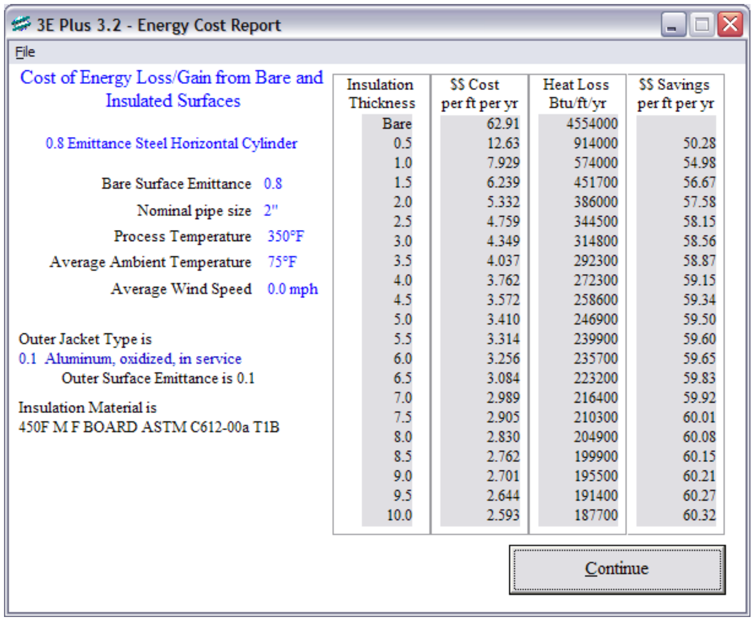
6. Improve Steam Distribution System Insulation (near term)

With fuel prices approaches $9 per million Btu, any pipe greater than 2-inches in diameter with a surface temperature greater than 180°F is a candidate for insulation. The screen shot below is a 3EPlus model run that shows the cost savings possible when insulating 2-inch pipe with a surface temperature of 180°F. If a reasonably large quantity of insulation is required, the installed cost of insulation for this pipe is estimated at $15 to $20 per lineal foot. The simple return would be in the range of 1 to 1.5 years.



Insulation Thickness	$$ Cost per ft per yr	Heat Loss Btu/ft/yr	$$ Savings per ft per yr
Bare	17.26	1250000	
0.5	3.747	271200	13.51
1.0	2.401	173800	14.86
1.5	1.907	138000	15.35
2.0	1.638	118600	15.62
2.5	1.467	106200	15.79
3.0	1.344	97280	15.92
3.5	1.250	90500	16.01
4.0	1.167	84470	16.09
4.5	1.109	80290	16.15
5.0	1.060	76720	16.20
5.5	1.031	74610	16.23
6.0	1.013	73300	16.25
6.5	0.9599	69490	16.30
7.0	0.9310	67390	16.33
7.5	0.9052	65530	16.35
8.0	0.8821	63860	16.38
8.5	0.8613	62350	16.40
9.0	0.8424	60990	16.42
9.5	0.8252	59740	16.43
10.0	0.8093	58590	16.45

The screen shot below shows the value of insulating 2-inch diameter *steam* pipe. The cost for the insulation, again assuming that there is a reasonable amount of insulation to be installed, is approximately $15 to $20 per lineal foot. At this price the simple return is approximately 6 to 9 months.



3E Plus 3.2 - Energy Cost Report

File

Cost of Energy Loss/Gain from Bare and Insulated Surfaces

0.8 Emittance Steel Horizontal Cylinder

Bare Surface Emittance 0.8
Nominal pipe size 2"
Process Temperature 350°F
Average Ambient Temperature 75°F
Average Wind Speed 0.0 mph

Outer Jacket Type is
0.1 Aluminum, oxidized, in service
Outer Surface Emittance is 0.1

Insulation Material is
450F M F BOARD ASTM C612-00a T1B

Insulation Thickness	$$ Cost per ft per yr	Heat Loss Btu/ft/yr	$$ Savings per ft per yr
Bare	62.91	4554000	
0.5	12.63	914000	50.28
1.0	7.929	574000	54.98
1.5	6.239	451700	56.67
2.0	5.332	386000	57.58
2.5	4.759	344500	58.15
3.0	4.349	314800	58.56
3.5	4.037	292300	58.87
4.0	3.762	272300	59.15
4.5	3.572	258600	59.34
5.0	3.410	246900	59.50
5.5	3.314	239900	59.60
6.0	3.256	235700	59.65
6.5	3.084	223200	59.83
7.0	2.989	216400	59.92
7.5	2.905	210300	60.01
8.0	2.830	204900	60.08
8.5	2.762	199900	60.15
9.0	2.701	195500	60.21
9.5	2.644	191400	60.27
10.0	2.593	187700	60.32

Continue

In addition to steam, condensate and hot water lines, shell and tube heat exchangers, valves and regulators are also worthy of insulation. The table below was developed from a "Fact Sheet" provided by the Department of Energy concerning the cost of not insulating valves with removable insulation 2-inches thick.

Table 1

Pressure	**Temperature**	**Energy savings (Btu/hr) based on valve size**						
psig	F	2	3	4	6	8	10	12
55	300	2,420	3,630	4,340	6,500	8,670	10,300	13,010
230	400	4,173	6,260	7,470	11,210	14,940	17,750	22,420
130	356	3,402	5,103	6,093	9,138	12,181	14,472	18,280

There were at least fifteen (15) 2-inch or larger valves noted where removable insulation can be applied. Use on removable insulation on a two-inch valve at 130-psig (steam) will save approximately 3,402-Btu/hr. The estimated annual cost savings if all fifteen vales wrapped are 2-inch in size is approximately:
3,402-Btu/hr x 15 x 8,760-hr/yr x $14.43/1,000-lb ÷ 1,000-Btu/lb = $6,450

This savings is approximately equivalent to a steam demand reduction of 51-pph.

The cost of the blankets is estimated at $400 each for a total of $6,000, providing a simple return of slightly less than one year.

A few suppliers are provided below for convenience but no endorsement of any particular supplier is implied.

- B&B insulation: 920.733.6086
- Advance Thermal Corporation: 630.595.5150
- Coverflex Manufacturing: 713.378.0966

Ceramic Spray Insulation

Kinergetics has evaluated the thermal performance of ceramic spray insulation *on pipes* for other clients and has found it to be an effective option as long as surface temperatures are not too high (<400°F). Based on an application thickness of 70-mils (~0.071-inch) and the material cost of about $40 to $50/gallon, the approximate cost for any particular application can be estimated. Experience shows that installed cost can vary considerably, so it is best to have a specific application reviewed.

When considering *stainless steel* the savings is approximately 40-percent less than for black pipe because black pipe radiates heat (emissivity ~0.8) more efficiency than does stainless steel (emissivity ~0.3). Nevertheless, ceramic insulation can be effective if the surface temperature is high enough.

Notes:

1. Consider an insulation assessment to identify opportunities to insulate steam, condensate and boiler feedwater piping.

Management Support and Comments:
Generally, the initial feedback on the ESA was favorable and facility staff was engaged, helpful and interested.

DOE Contact at Plant/Company: Tim Hasbargen

Plant Contact: Tim Hasbargen

Company Contact: Tim Hasbargen